

Possibilities to Produce Additional Quantities of Woody Biomass from Small-Scale Private Forests in Croatia, Bosnia and Herzegovina and Serbia

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Abstract

Private forests in Croatia, Bosnia and Herzegovina and Serbia are highly fragmented into small plots of land with low productivity level and a large number of owners. Nevertheless, they are recognized in the strategic plans and programs concerning renewable energy as having a significant potential for woody biomass production. A regional research was conducted among 350 private forest owners in each of the three South-East European countries, Bosnia and Herzegovina, Croatia, and Serbia. It analyzed management activities and readiness of private forest owners to produce additional quantities of woody biomass. Smart regulation principles were selected as analytical framework in order to understand how the design of forest policy instruments, based on specific characteristics of the target groups, can contribute to the improvement of private forest owners' readiness to mobilize additional quantities of woody biomass from their forests. The results of this research indicated that although the majority of private forest owners use their forests for producing firewood to meet their own needs – 91.2% of private forest owners in Croatia, 85.0% in Bosnia and Herzegovina and 89.7% in Serbia, there is economic interest of private forest owners to produce additional quantities of woody biomass beyond their own fuelwood household consumption – 43.9% in Croatia, 45.8% in Bosnia and Herzegovina and 54.8% in Serbia. Moreover, private forest owners' socio-demographic characteristics, forest property characteristics and management objectives significantly impacted the owners' readiness to produce additional quantities of woody biomass. The readiness for woody biomass mobilization could be increased by providing different policy instruments, since this is deemed important by private forest owners. Hence, forest policy recommendations were proposed that may support the private forest owners' readiness to produce additional quantities of woody biomass.

Keywords: woody biomass, mobilization, private forest owners, forest policy, smart regulation

1. Introduction

The demand for renewable energy sources has increased over the last decade due to raised awareness of global climate change caused by greenhouse gases accumulation, the desire to achieve energy independence and the creation of economic opportunities in the rural areas (Hetemäki et al. 2014). Woody biomass is consid-

ered as a mitigation tool against climate change, as well as a promising source of energy and a variety of bio-based products (Hetemäki et al. 2014). At the European Union (hereinafter EU) level, policies such as the Renewable Energy Directive (Directive on the Promotion of the Use of Energy from Renewable Sources 2009)¹, Forest Strategy (Forest Strategy 2013), Climate and Energy Framework for 2030 (Commission 2014) and

¹ In 2016 the Commission published a proposal for a revised Renewable Energy Directive to make the EU a global leader in renewable energy and ensure that the target of at least 27% renewables in the final energy consumption in the EU by 2030 is met

the Paris Agreement, have been implemented and have made provisions for promoting woody biomass.

The EU Wood study (Mantau et al. 2010) has investigated the feasibility of meeting the increasing EU wood demand for energy and material use through domestic supply. Upon comparison of the potential demand for wood for all uses with the »realistic« potential supply in 2020 and 2030, it was found out that, under a medium biomass mobilization scenario, the expected demand is likely to exceed the potential by 2020. Consequently, imports from non-EU countries will be required (Hewitt 2011, Proskurina et al. 2016), whilst the energy use will outperform the material use. Consequently, it is necessary to implement a far more intensive use of forest resources (Lindstad et al. 2015, Pezdevšek Malovrh et al. 2016, Proskurina et al. 2016) and mobilize large woody biomass potential from small-scale privately owned forests across the EU (Blennow et al. 2014, Hetemäki et al. 2014, Moiseyev et al. 2011).

In response, European countries have developed and implemented the regulations mostly through National Renewable Energy Action Plans (hereinafter NREAP), to meet renewable energy targets. As Croatia has recently joined the EU, Serbia is EU candidate countries and Bosnia and Herzegovina (hereinafter BH) is potential EU candidate, and simultaneously, these countries are the parties of the Energy Community Treaty of the EU, they are in the process of harmonization of their national legislation with the EU policies concerning renewable energy. In line with the development of the EU energy sector, in 2009 Croatia adopted the Energy Strategy of the Republic of Croatia until 2020 (Energy Strategy... 2009). The strategy has set a target and recognized locally available forest biomass as one of the potential sources for meeting the energy targets by introducing co-generation (CHP) facilities from renewables (Delomez 2012). However, the strategy has not specified any particular action for increasing energy wood production from private forests (Halder et al. 2014). Moreover, the Croatian government has adopted the NREAP in 2013 (National Action Plan... 2013) with a target to achieve 20% share of renewables in its primary energy consumption by 2020, as compared to 15% achieved previously. Therefore, it is expected that the importance of energy production from forest biomass will increase. According to Pašičko et al. (2009), total available forest woody biomass for energy could be around 3.5 mil. m³ at an annual level, or 15% in total energy consumption.

Serbia signed and ratified the Energy Community Treaty in 2003 (Law on Ratifying... 2003) and adopted the Biomass Action Plan in 2010 (Biomass Action Plan 2010). In 2013, the NREAP until 2020 was adopted (National Renewable... 2013), where clear objectives were defined in terms of conditions for the production of energy from renewable energy sources. Moreover, in 2015 Energy Sector Development Strategy of the Republic of Serbia until 2025 was adopted, with projections until 2030 (Official Gazette of RS, NN. 101/15), where woody biomass was identified as large potential source for energy production. According to Glavonjić et al. (2017), it was identified that potential supply of wood biomass was 7.97 million m³ annually and the annual use of 7.5 million m³ for energy. The total estimated potential for additional supply was 469 000 m³ annually.

BH signed and ratified the Community Treaty in 2006 (Energy Community Treaty 2006). In BH, the National Energy Development Strategy for BH was prepared, whilst the Energy Strategies at entities level (the Republic of Srpska and the Federation of Bosnia-Herzegovina) were adopted (Strategy for Development... 2010, Strategic Plan 2009). Strategic documents of both entities indicated that biomass from forest as well as wood residues from wood-processing industry represent significant potential for energy production. According to the UNDP (2014), the available woody biomass in private and state forests that could be mobilized in BH is over 3.7 million of m³. Around 32.7% of available woody biomass is already in use in the form of fire wood, whilst other potential sources of biomass (e.g. residues after cutting and production of forest wood products, small branches, residues in wood-processing industry and stumps) are less used for energy production (Glavonjić et al. 2017).

Similarly as in other countries, strategic plans and programs provide detailed roadmaps of how each country expects to reach its targets for the share of renewable energy in its final energy consumption harmonized with the EU policies. A stronger energy wood mobilization from private forests is required in order to meet these targets (Halder et al. 2014).

The conditions of privately-owned forests in the analyzed countries², are characterized by a huge number of owners, a high fragmentation and very small forest properties (an average property size is less than 1 ha in all the countries), unclear property boundaries and poor growing stock compared with the state-owned forests (Čavlović 2010, FAO 2015, Glück et al.

² The share of private forests in Serbia is 47%, in Croatia 23% and in BH 20% (Čavlović 2010, FAO 2015, Vukmirović 2012)

2010, 2011, Pezdevšek Malovrh et al. 2011, 2015, Živojinović et al. 2015). Woody biomass mobilization will be influenced by private forest owners' (hereinafter PFOs) use of the land and the way they manage their forests. Moreover, it will be influenced by their readiness to supply woody biomass for the energy market (Blennow et al. 2014, Curman et al. 2016), especially as strategic plans and programs have not proposed any specific actions for increasing energy wood production from private forests (Halder et al. 2014). Taking into consideration that private forests are fragmented, with unclear ownership structure and in some cases not accessible, the PFOs in these countries generally show a lack of interest in managing their forests (Glück et al. 2011). Trying to deal with these adverse conditions in private forests in the analyzed countries and in order to mobilize woody biomass potential to meet the national energy objectives, the perception, attitudes and motivation of PFOs, as well as the possibility to produce additional quantities of woody biomass need to be analyzed. In response to the fact that the importance of bioenergy has been growing over the last decades, a number of studies were conducted primarily in Europe (e.g. Bohlin and Roos 2002, Brough et al. 2013, Halder et al. 2014, Rämö et al. 2009, Wilnhammer et al. 2012) and North America (e.g. Becker et al. 2013, Guo et al. 2013, Guo et al. 2007, Joshi et al. 2013, Markowski-Lindsay et al. 2012, Shivan 2009, Shivan and Mehmood 2010, Shivan and Mehmood 2012). These studies address PFOs' perception, attitudes, preferences and motivation concerning the woody biomass production, and the factors affecting PFOs readiness to harvest or supply woody biomass. Similarly, there has been growing interest in these topics in the analyzed countries as well (Halder et al. 2014, 2017, Posavec et al. 2015, Curman et al. 2016).

Halder et al. (2014) conducted surveys on PFOs in Serbia and Croatia, where they studied the owners' perception and attitudes related to energy wood production. The results of this paper indicated that socio-demographic background of PFOs had statistically significant relation to their attitudes towards producing energy wood from their forests. PFOs identified and considered undeveloped market and low price for energy wood, the absence of favorable policies, fragmented forests properties, older owners' lack of interest in energy production, and difficulties in getting a bank loan for energy wood-related business activities, as obstacles to energy wood production from private forests. Posavec et al. (2015) studied PFOs willingness

to supply wood biomass in the selected South-Eastern European countries, also including Croatia, BH and Serbia. The study identified the factors that influence PFOs willingness to supply wood biomass, with a focus on different management objectives (i.e. timber production, investment, game management and heritage) and forest and forest ownership characteristics. Moreover, the research showed a relatively high degree of willingness to manage forests in order to produce woody biomass. Curman et al. (2016) analyzed PFOs willingness to supply woody biomass in Croatia and found out that the willingness to supply woody biomass was influenced by property size, management objectives (production of fuel wood for personal needs and using forest for outdoor recreation), cooperation with other forest owners and the owners' age. Halder et al. (2017) studied PFOs' perceptions of energy wood mobilization in Croatia and Serbia and found out that PFOs did not have adequate knowledge of selling energy wood, its price and energy wood entrepreneurship. The most significant obstacle to mobilizing energy wood from private forests was the absence of proper forest roads and the main motivation for energy wood production appeared to be the expected income from such activity. They also found out that the PFOs would prefer supplying energy biomass from new plantations and harvesting residues instead of using the existing forests.

The above studies have produced extensive information on PFOs' perception and attitudes related to energy wood production and their willingness to become involved in it but did not focus on how PFOs used their forests and the way they managed them, or on the possibilities to increase the woody biomass production. Consequently, the specific objective of this study was to:

- ⇒ analyze whether PFOs have managed their forests in the past 10 years and for what purposes
- ⇒ identify whether PFOs are prepared to produce additional quantities of woody biomass for the market³
- ⇒ understand how PFOs' characteristics, forest management objectives and property characteristics affect PFOs' readiness to produce additional quantities of woody biomass
- ⇒ identify different obstacles and policy instruments preferred by PFOs for promoting woody biomass production, as this would support the increased demand.

³ More woody biomass production means biomass from the forest, with the exception of firewood for personal use

The results of this study will provide useful recommendations for policy makers in order to help them design and implement an appropriate policy mix intended to support the mobilization of woody biomass production from private forests. This research represents an additional step towards the target-oriented policy measures related to increased woody biomass production from private forests in these specific countries.

2. Materials and methods

2.1 Data collection

A survey of PFOs was conducted in Croatia, BH, and Serbia, to assess PFOs management activity and the possibilities to increase woody biomass production based on PFOs' readiness to produce additional quantities of woody biomass and in order to understand the differences between those who are prepared to produce additionally and those who are not. The countries were selected due to their regional similarities concerning governmental and institutional development, private forest ownership and legislative framework.

Random samples for the surveys of PFOs in each country were drawn from the experiences of the PRIFORT⁴ project (Glück et al. 2011) that was based on overlapping municipalities with the highest percentage of forest area and the highest share of private forests. This ensured that the main bulk of PFOs were included in the research. Within these municipalities, 35 settlements with 10 respondents within each settlement were randomly selected by the use of the Research Randomizer (Geoffrey et al. 2012), yielding a total sample size of 350 respondents for each country (Glück et al. 2010, Glück et al. 2011). Due to the confidentiality concerns, non-respondents were not followed, so that the differences in relation to the respondents were not estimated. The representativeness of the sample was checked by inspecting the spatial distribution of the respondents to check whether they were randomly distributed across the analyzed countries.

The questionnaire was designed within the WESSPROFOR⁵ project, which consisted of five sections seeking information on owners' socio-demographic characteristics (e.g. age, occupation), private forest characteristics (e.g. property size, number of plots of

land, type of forest, distance from the place of residence to the forest), forest management and management objectives (e.g. timber production, heritage, future investment, etc.), readiness to co-operate with other PFOs and the opinion about additional woody biomass production from their forests. In section four, several questions were asked, aiming to collect information on the PFOs' motivation concerning the increased woody biomass production, their readiness to produce a higher quantity of woody biomass, the main obstacles for woody biomass production and the preferred policy instruments for promoting woody biomass. The questionnaire was developed based on the previous research regarding PFOs' readiness to produce biomass from forests in Europe and North America considering country-specific conditions of private forests in the analyzed countries. The questionnaire was pre-tested in May 2012 and the survey data was collected between May and December 2012.

2.2 Data analysis and variable definitions

In order to check the quality of the data and to detect the miss-entered, outliers and missing values, all data was first frequency checked. In order to determine the normality of the data, normality tests (Kolmogorov-Smirnov and Shapiro-Wilk) were used (Field 2009). In this case, data was not normally distributed, therefore, non-parametric tests were used (Field 2009). As one of the objectives of this study was to understand how PFOs' characteristics, forest management objectives and property characteristics affected PFOs' readiness to produce additional quantities of woody biomass, the comparison was made between the PFOs who were prepared to produce additional quantities of woody biomass and those who were not. Hence, in order to determine the differences between these two groups, the non-parametric Mann-Whitney *U* test for continuous and ordinal variables and Person's chi-square for nominal variables were used. The main comparisons were made concerning the PFOs' forest property characteristics, forest management objectives and PFOs' socio-demographic characteristics (Table 1) identified and analyzed in the previous research (e.g. Joshi et al. 2013, Joshi and Mehmood 2011, Posavec et al. 2015). The first group of variables related to PFOs' forest property characteristics included the variables such as forest property

⁴ PRIFORT project (Research into Organization of Private Forest Owners in the Western Balkan Region) was financed by the Ministry of Agriculture, Forestry, Environment and Water Management of Republic of Austria

⁵ WESSPROFOR project (Opportunities for Wood Energy Production from Small-Scale Forests in the South-Eastern Europe Region) was a part of the FOPER II project, financed by the Ministry of Foreign Affairs of Finland and coordinated by the European Forest Institute

Table 1 Definition and coding system of variables

Variables	Categories
Forest property size	Continuous
Number of plots of land	Continuous
Type of forest	1 – High forest 2 – Coppice 3 – Mixed forest
Distance from residence to forest	Continuous
Age	Continuous
Occupation	1 – Employed 2 – Unemployed 3 – Retired
Management objectives Timber production Heritage Investment for the future	1 – Very important 5 – Very unimportant

size, the distance from the PFOs' residence to the forest, the number of plots of land and the type of forest. The second group of variable related to forest management objectives included variables that captured harvesting experiences (timber production), future investment and heritage⁶. The third group of variables included socio-demographic characteristics, such as age and occupation. Relationships between variables were classified as statistically significant, with the p-value lower than 0.05. The data was analyzed using the SPSS 20. Statistical Software (Corp. IBM 2011).

2.3 Analytical framework

From the policy perspective, new legislations harmonized with the EU policies were emerging in the analyzed countries concerning woody biomass production, where detailed guidelines of how each country expected to reach its target for the share of renewable energy in its final energy consumption were formulated. Consequently, in order to increase woody biomass production from private forests, a wide range of different policy instruments is required, as well as a more effective policy co-ordination and strong support from policy decision-makers (especially public forest administration, i.e. Forest Advisory Service and the ministries responsible for forestry).

Smart regulation principles were selected as the analytical framework for this study, considering the fact that the existing policy instruments are mainly

legislative instruments with a pronounced role of state control. The smart regulation framework consists of the principles that should guide the design of policy instruments in order to overcome these problems (Gunningham 2007, Gunningham and Grabosky 1999, Gunningham and Sinclair 1999, Van Gossum et al. 2012). The framework proposes a number of principles that help policy makers to »smartly« formulate their instrument design, ultimately generating an instrument design that will achieve the desired policy outcome (Van Gossum et al. 2012). Through these instruments, policy-makers are able to effectively support target population in addressing various challenges, whilst the selection of implementation instruments has to be performed strategically. A smart regulation framework comprises of two basic elements: regulatory design principles and instrument mixes (Gunningham and Grabosky 1999). According to Van Gossum et al. (2012), the smart regulation principles are as follows:

- ⇒ avoid »perverse« or adverse effects of other (ad-joining) policies
- ⇒ select policy mixes that incorporate a broad range of instruments
- ⇒ choose policy mixes incorporating a broad range of institutions
- ⇒ develop or use new policy instruments, when »traditional« instruments fail
- ⇒ invoke motivational and informative instruments
- ⇒ prefer less interventionist measures, yet still capable to deliver the identified policy outcome
- ⇒ use instrument sequencing
- ⇒ maximize opportunities for win-win outcomes.

These principles of the smart regulation framework show a wide range of differences and allow a complementary combination of instruments and co-operation between the major stakeholders also in the field of woody biomass mobilization.

3. Results and discussion

3.1 PFOs forest management

PFOs in the analyzed countries are active in terms of forest management, as 89.1% of them harvest timber in Serbia, 83.1% in BH and 73.7% in Croatia. During the last 10 years they have harvested on average 142.5 m³ in Croatia, 180.0 m³ in Serbia and 76.0 m³ in BH. The only impeding factor for additional utilization is property size in the analyzed countries, as previous researches showed that the importance of firewood and

⁶ These management objectives were selected based on the fact that they are the top three in the analyzed countries

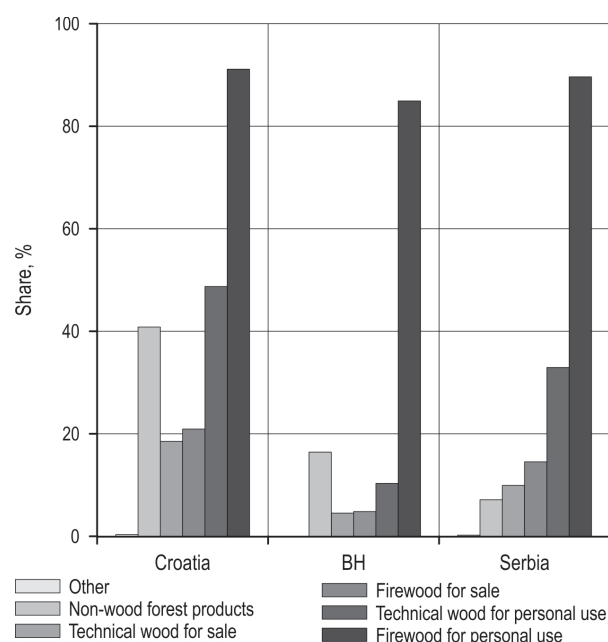


Fig. 1 Main use of forests (multiple answers)

self-consumption rise with decreasing forest property size (Blennow et al. 2014, Wilnhammer et al. 2012), which means that the supply of woody biomass for energy is related to self-consumption among PFOs of small properties. Although the majority of PFOs used their forests for producing firewood to meet their own needs (Fig. 1) – 89.7% in Serbia, 85.0% in BH and 91.2% in Croatia, some PFOs have their economic interest as there are PFOs who produce firewood and technical wood for sale. The entrepreneurial spirit of these PFOs might be a favorable pre-requisite for increasing the woody biomass production.

3.2 Readiness of PFOs to produce additional quantities of woody biomass

The readiness of PFOs to produce additional quantities of woody biomass differed amongst the analyzed

Table 2 Readiness of PFOs for additional woody biomass production (Posavec et al. 2015)

Country	Readiness of PFOs for additional woody biomass production	
	Prepared to produce additionally, %	Not prepared to produce additionally, %
Croatia	43.9	56.1
BH	45.8	54.2
Serbia	54.8	45.2

countries (Table 2). In Croatia and BH, PFOs who were not prepared to produce additional quantities of biomass prevailed, whilst in Serbia the situation was the opposite (Posavec et al. 2015).

Considering the fact that private forests in the analyzed countries are small and fragmented and difficult to be managed effectively (Glück et al. 2011), the relatively high readiness to produce additional quantities of woody biomass was unexpected. Even though private forests are predominantly used for domestic firewood production (Glück et al. 2011), supporting woody biomass for market can increase production and generate more income to PFOs especially in rural areas (Hetemäki et al. 2014, Wilnhammer et al. 2012). The fact that the share of PFOs, who are prepared to produce additional quantities of woody biomass, was relatively high indicates that it is possible to increase the woody biomass production and that target-oriented forest policy instruments should be created taking these facts into consideration.

3.2.1 Influence of socio-demographic characteristics on PFOs readiness to produce additional quantities of woody biomass

In the analyzed countries, PFOs who are prepared to produce additional quantities of woody biomass are younger than those who are not prepared to do so ($p < 0.001$). On average PFOs who are prepared to produce additional quantities of woody biomass are 48 years old in Serbia and up to 55 years old in Croatia. The difference in age between the two groups is small – 7–8 years in all the countries (Table 3).

Since the production of woody biomass for the market is a relatively new trend in the analyzed countries, it was expected that younger PFOs consider this option as one of the forest management goals and an entrepreneurial goal. As indicated in the previous re-

Table 3 Influence of socio-demographic characteristics on PFOs readiness to produce additional quantities of woody biomass

Country	Category	Mean age years	Occupation
Croatia	Prepared to produce	55.6 ***	Employed, 58.5% ***
	Not prepared to produce	63.0 ***	Retired, 67.5% ***
Serbia	Prepared to produce	48.1 ***	Employed, 63.6% ***
	Not prepared to produce	56.5 ***	Retired, 69.9% ***
BH	Prepared to produce	50.3 ***	Employed, 64.5% ***
	Not prepared to produce	57.8 ***	Retired, 46.1% ***

*** Variables are significant at $p < 0.001$

search, most PFOs have an economic interest in their forest, primarily related to the domestic firewood and domestic saw logs production (Glück et al. 2011). Furthermore, contributions to annual household income, in terms of returns from timber sales, are modest in all the countries (Glück et al. 2011).

Considering the fact that unemployment rate is relatively high among younger population in all the analyzed countries (World Bank 2017), woody biomass production can be considered as employment opportunity for PFOs. Moreover, increasing economic opportunities could influence depopulation processes in rural areas by increasing the readiness of younger private forest PFOs to become involved in entrepreneurial activities on their property. In the group of PFOs who are prepared to produce additional quantities of woody biomass, the majority of the respondents (over a half) are employed in all the analyzed countries. Moreover, statistically significant differences were identified between the two groups in all the analyzed countries, where those who were not prepared were mostly the retired PFOs.

3.2.2 Influence of forest property characteristics on PFOs readiness to produce additional quantities of woody biomass

In general, small-scale properties dominate in the analyzed countries, where a significant number of PFOs own properties smaller than 1 ha (Glück et al. 2011). Despite the fact that the average size of forest property varies between the analyzed countries (4.1 ha Serbia; 3.6 ha Croatia; and 3.2 ha BH) (Glück et al., 2011), it was confirmed that this variable exerts a significant impact on the readiness to produce additional quantities of woody biomass (Table 4). PFOs who are prepared to produce additional quantities of woody biomass owned bigger properties on average compared with those who were not prepared to do so – the differences between groups are statistically significant.

According to Glück et al. (2011), a relatively small number (19.0%) of PFOs own more than 2 ha of forests in BH, followed by Croatia (25%), whilst in Serbia this number exceeds 40%. Looking at these facts and considering the average forest property size of PFOs, who are prepared to produce additional quantities of woody biomass, it can be concluded that the possibilities for wood mobilization are higher in the countries with higher average property size.

The average number of plots of land differed among the analyzed countries (Table 4). PFOs who are prepared to produce additional quantities of woody biomass owned more plots of forest land on average compared with those who are not prepared to produce additional quantities. Statistically significant differences amongst the analyzed groups appear in BH, where PFOs who are prepared to produce additional quantities of woody biomass own on average more than 5 plots of land. Considering the fact that over three quarters of private forests in BH are highly fragmented, it is not surprising that PFOs with more fragmented property were prepared to produce additional quantities of woody biomass. This is due to the fact that most private forests are not managed regularly and woody biomass production could be considered as an appropriate way of increasing management activities, as well as forest conditions in general.

The influence of the average distance between the place of residence and the forest on the readiness for production of additional quantities of woody biomass was also analyzed (Table 4). The differences among the countries were identified in terms of distribution into groups that were prepared to produce additional quantities of woody biomass or those that were not prepared to do so, considering the distance from the place of residence. The analyzed data indicated that, in BH and Croatia, the PFOs who lived further from their property were prepared to produce additional quantities of woody biomass, whilst in Serbia the situ-

Table 4 Influence of property characteristics on PFOs readiness to produce additional quantities of woody biomass

Country	Category	Average property size, ha	Average number of plots	Average distance from residence	Predominant Forest type
Croatia	Prepared to produce	4.9 ***	5.9	7.9	High forest, 50.4%
	Not prepared to produce	1.8 ***	4.1	5.6	Mixed, 56.0%
Serbia	Prepared to produce	4.9 ***	5.0	11.2	Mixed, 44.2% **
	Not prepared to produce	2.8 ***	4.5	13.3	Coppice, 71.1% **
BH	Prepared to produce	4.5 ***	5.3 ***	4.0 **	Mixed, 56.0%
	Not prepared to produce	1.8 ***	3.6 ***	2.5 **	Mixed, 44.3%

** Variables are significant at $p < 0.05$; *** Variables are significant at $p < 0.001$

ation was the opposite. Significant differences amongst the two groups were observed only in BH.

Statistically significant differences between the PFOs who are prepared to produce additional quantities of woody biomass and those who are not prepared to do so, concerning the type of forest were found in Serbia, whilst in BH and Croatia the differences were not statistically significant (Table 4). In Serbia PFOs who were prepared to produce additional quantities of woody biomass were mainly those who owned mixed forests, whilst in the group of PFOs who were not prepared to do so the predominant type of forest was coppice. The PFOs who owned mixed forests, due to higher economic benefits in case of use of more wood from mixed forests, showed an increasing readiness to produce additionally compared to those who owned small coppice plots of forest land.

3.2.3 Influence of forest management objectives on PFOs readiness to produce additional quantities of woody biomass

According to the analyzed data, PFOs' management objectives in the countries primarily focused on retaining forests as an investment into the future, leaving it as heritage and timber production. Consequently, these management objectives were analyzed between the two groups of PFOs concerning the readiness to produce additional quantities of woody biomass (Table 5), based on the average value of management objective importance.

Retaining forests as investment for the future was of relatively high importance for PFOs in all the countries. Generally, those PFOs that pointed out higher importance of forests as investment for the future on average were not prepared to produce additional quantities of woody biomass. Significant differences amongst the groups were present in BH and Serbia.

Table 5 Influence of management objectives on PFOs readiness to produce additional quantities of woody biomass

Country	Category	Investment for the future	Heritage	Timber production
Croatia	Prepared to produce	2.95	2.43	1.87
	Not prepared to produce	3.10	2.44	1.90
Serbia	Prepared to produce	2.57 ***	1.92	2.03 ***
	Not prepared to produce	3.18***	2.11	2.60 ***
BH	Prepared to produce	2.51 ***	1.48 **	2.28
	Not prepared to produce	3.19 ***	1.68 **	2.04

Mean values are calculated in table (1–very important, 5–very unimportant)

** Variables are significant at $p < 0.05$; *** Variables are significant at $p < 0.001$

These findings are in line with the real condition of forest properties in the analyzed countries, where small and fragmented properties are dominant, yet also against unfavorable economic and social conditions of living. The PFOs are future-oriented and, although their forests are not of great economic value, keeping them without active forest management gives them some kind of financial security for the future. Similar findings were related with heritage as management objective, with the exception of the fact that significant differences amongst the analyzed groups were identified in BH. The above mentioned management objectives are considered as an impeding factor for increasing the woody biomass production, since evidence from the previous studies shows that the way PFOs use and manage their forests is influenced by other than economic factors (Blennow et al. 2014) – PFOs are often motivated to owning forests for multiple reasons, which, in case of increasing the woody biomass production, can come into conflict with personal values (Blennow et al. 2014).

It can be highlighted that the PFOs who considered timber production, on average, as a less important management objective, were included in the group of PFOs who were not prepared to produce additional quantities of woody biomass with the exception of BH. Bearing in mind that considerable amount of PFOs in BH had other management objectives and that forest property is fragmented and often inaccessible, the PFOs were focused on traditional timber production patterns. In some way, this prevents PFOs from being interested in other management practices approaches, including woody biomass production. The importance of timber production as management objective was significantly different amongst the analyzed groups in Serbia. It was not surprising that the PFOs, who rated this management objective as more important on average, were included in the group of PFOs prepared to produce additional quantities of woody biomass. In general, in the analyzed countries, economically profitable woody biomass production is constrained by quality of standing wood, access to forest and possession of management equipment and, in cases where forests are of lower quality and easily accessible (open with forest roads), the production of additional quantity of woody biomass could be expected.

3.3 The main supporting and impeding factors for additional woody biomass production

In general, the obstacles for woody biomass production did not differ significantly among the analyzed countries (Table 6).

Table 6 The main obstacles impacting the readiness for additional woody biomass mobilization

Country	Category	Obstacles, %			
		Lack of equipment	Lack of funding	Labor shortage	Lack of forest roads
Croatia	Prepared to produce	60.8	73.8	58.5 ***	43.8
	Not prepared to produce	57.8	78.3	72.9 ***	40.4
	All PFOs	61.4	75.4	66.7	43.9
Serbia	Prepared to produce	65.8 ***	64.5	41.9 ***	50.3
	Not prepared to produce	50.8 ***	60.2	58.6 ***	46.9
	All PFOs	60.3	66.3	50.9	48.6
BH	Prepared to produce	92.2 ***	94.3 ***	39.7 ***	61.0 ***
	Not prepared to produce	81.4 ***	83.8 ***	56.3 ***	53.3 ***
	All PFOs	85.4	87.7	47.1	58.0

** Variables are significant at $p < 0.05$

In general, both categories of PFOs in Croatia identified the same obstacles – the statistically significant difference was identified only for the obstacle of the »labor shortage« where PFOs, who were not prepared to produce additional woody biomass, perceived it as more important than the PFOs who were prepared to produce additionally. PFOs are mainly rural or semi-rural people, living in small settlements (less than 5000 inhabitants) (Glück et al. 2011). In addition to the migration to major cities, low-income elderly population with labor shortage is not able to organize forest management requirements.

The situation is similar in Serbia and BH where the majority of the respondents identified the lack of funding as the most important obstacle affecting the readiness for additional woody biomass mobilization (Table 6). In Serbia, a great number of PFOs stated that the lack of equipment, as well as the labor shortage, greatly affected their readiness to produce additional quantities of woody biomass. Due to small plots of forest land, PFOs were interested in getting subsidies for forest equipment that can be used as a common benefit for many of them and create opportunities to use more wood. The differences between PFOs were identified concerning the lack of equipment and labor shortage. Those who were prepared to produce additional woody biomass perceived the lack of equipment as a more important obstacle. The PFOs, who identified a lack of equipment as obstacle, perceived more opportunities for increasing their activities outside their property, yet a large investment necessity for purchasing equipment prevented them from increasing the mobilization of wood. The results were

quite the opposite with regard to labor shortage where the ageing of local population and migration from rural to urban areas, including working abroad, poses challenges in terms of adequate and sufficient labor in harvesting operations.

Summarizing the analyzed results for BH, the most impeding factors identified include the lack of funding, followed by the lack of equipment and the lack of forest roads (Table 6). The PFOs that were prepared to produce additional woody biomass perceive the lack of equipment, the lack of funding and the lack of forest roads as the most important obstacles, whilst those who were not consider the labor shortage as the most important obstacle. These findings are in line with the general economic situation in BH that is characterized by high unemployment rate and severe poverty, especially in rural areas. The PFOs, who would be prepared to produce additional quantities of woody biomass, would face difficulties to organize forest management activities without adequate equipment and access to forest property.

On the other hand, almost all PFOs stated that the provision of policy instruments is important for improving their readiness for woody biomass mobilization (Fig. 2). The results indicated that PFOs preferred the subsidies for woody biomass production compared to other policy instruments (subsidies for equipment for forest management activities and a forest tax reduction). These findings are in line with the identified obstacles and, in general, correspond to the preferences of PFOs concerning the issue of increasing the woody biomass production (Halder et al. 2017, Halder

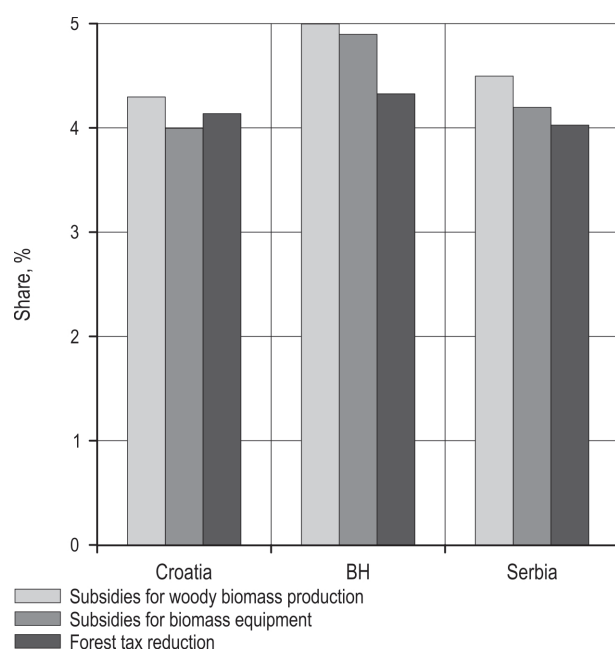


Fig. 2 The most important policy instruments for woody biomass production (average values of 5-point Likert scale)⁷

et al. 2014). The highest importance of the analyzed policy instruments is indicated in BH followed by Serbia, and Croatia. These results clearly demonstrate that the readiness for woody biomass mobilization depends on incentives and support, indicating that a mix of forest policy instruments, especially economic ones, needs to be applied in order to increase woody biomass mobilization in small-scale forests in the analyzed countries.

4. Conclusions and policy recommendations

Woody biomass is the major source of renewable energy in Europe and in the analyzed countries. Consequently, policies should follow long term demand for this resource (Verkerk et al. 2011). The mobilization should target unused or under-used wood resources from privately owned and state-owned forests (Hetemäki et al. 2014) in order to increase the production of additional quantities of woody biomass.

Since PFOs own a significant share of forest area in the analyzed countries, their forest management decisions are likely to seriously affect the availability of woody biomass in the future. Recently, policy makers made some initiatives in the analyzed countries in or-

der to improve the infrastructure and technical expertise related to bioenergy production from woody biomass. However, the possibility to increase the woody biomass production will be influenced by PFOs positive attitude towards woody biomass production from their forests, as well as their readiness to supply woody biomass for the energy market. Nevertheless, the prerequisites for transforming their positive attitudes into action should be created. Consequently, adequate policy instruments targeting PFOs, who are prepared to produce additional quantities of woody biomass and those who are not, play an important role in the future woody biomass production (Jacobsson et al. 2009, Stern et al. 2013, Thornley and Cooper 2008), as well as in creating a stable market for woody biomass (Halder et al. 2014).

This is in line with our results from analyzed countries. Hence, two groups of forest policy instruments can provide the prerequisites for the mobilization of additional woody biomass from private forests in these countries. The first group labeled as *»General forest policy instruments«*, includes all the measures that can be applied to both identified groups of PFOs (Table 3). These measures aim at overcoming the obstacles that affect the production of additional quantities of woody biomass specified by the PFOs. The second group comprises of the *»Group-specific forest policy instruments«* and include the measures that correspond to the specific characteristics of PFOs on the basis of their readiness to produce additional quantities of woody biomass.

The proposed *»general forest policy instruments«* are related to all types of instruments that should create a positive operational environment for forest management, including wood mobilization and production of additional quantities of woody biomass. Hence, a mix of forest policy instruments that incorporates a broad range of instruments should be developed, which is in accordance with the second requirement of the applied framework (Van Gossum et al. 2012). Consequently, governments need to provide the legal framework to enable more creative operational environment by removing legal constraints, e.g. reducing administrative barriers in starting woody biomass business. Furthermore, the prevention of further fragmentation of private forest properties needs to be regulated. In the analyzed countries, there are serious administrative barriers for those who want to start business in bio-energy (Stevanov et al. 2013). Fast and simple procedures and flexibility would be preferred.

⁷ 1 – very unimportant, 3 – neither unimportant nor important, 5 – very important

According to the fifth requirement of Smart Regulatory Framework, informational and motivational instruments are also needed to increase the PFOs' readiness to act. Consequently, information sharing and extension services may be equally effective and even more effective than regulatory instruments. Informational instruments should focus on giving information to PFOs on biomass production (better utilization of logging residues) and markets, possible woody biomass businesses and availability of subsidies or bank loans to start the business. Moreover, information about the benefits and opportunities concerning the PFOs co-operation in woody biomass production, in addition to financial support for the business launch, should encourage PFOs to co-operate or consider different forms of co-operation (e.g. interest associations, cooperatives or machinery rings). This is in line with previous studies in the analyzed countries that identified co-operation as a significant factor that affects the readiness to produce additional quantities of woody biomass (Curman et al. 2016) and existence of PFOs who are also willing to co-operate with other PFOs in woody biomass production (Posavec 2015). In this context, forms of cooperation with clear objectives and strong capacities could motivate PFOs to act, particularly the younger, so that PFOs should benefit from forms of co-operation as they provide management and marketing support and services, such as technical and financial support, information and knowledge transfer. In 2017, there were 52 local PFOs associations registered in Croatia, two in BH and seven in Serbia (FAO 2015, Nonić et al. 2016, Živojinović et al. 2015). However, these associations need to increase the efficiency of their operations, as it is crucial for success. In the analyzed countries, there is currently certain institutional and financial support for the establishment and operational costs of PFOs associations or any other forms of co-operation but it is early to evaluate the effectiveness of these recently introduced measures. Only the forms of co-operation with clear objectives and effective operations could provide better education and information for PFOs about the benefits of biomass production and the emerging markets (prices, distribution).

Furthermore, the general impression is that, despite their readiness to produce additional quantities of woody biomass, PFOs need strong, well organized and continuous financial support from the state. This is due to characteristics of forest properties (small and fragmented estates) that prevent profitable forest management activities.

Moreover, the results showed that PFOs recognized the lack of forest roads as one of the most im-

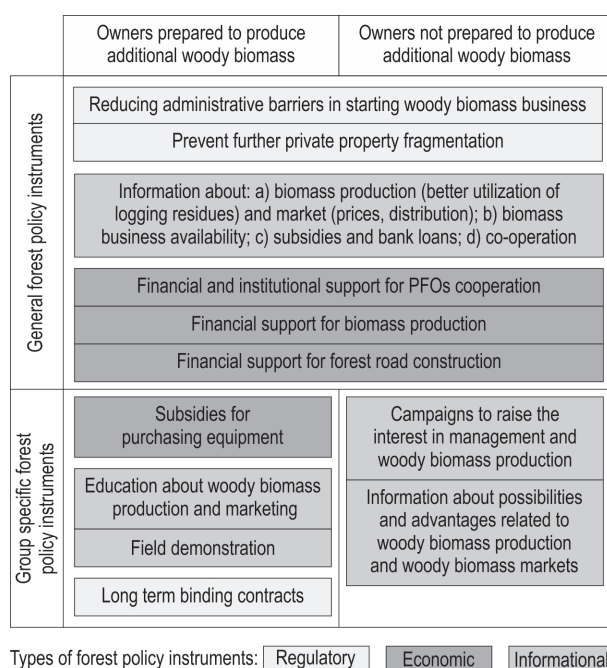


Fig. 3 »Smart« policy mix framework for production of additional quantities of woody biomass from small-scale forests in the analyzed countries

portant obstacles for additional woody biomass mobilization. This is not surprising, since in the analyzed countries the density of forest road network is very low (Avdibegović et al. 2010). Hence, additional financial assistance for forest road construction is required, as the presence of an adequate forest access network and other infrastructure is a crucial prerequisite for increasing woody biomass mobilization (Forest Europe 2010).

Group »specific forest policy instruments« are divided into two groups based on PFOs' readiness to produce additional quantities of woody biomass. For those who are prepared to produce additional quantities of woody biomass, economic instruments (e.g. subsidies for the purchase of equipment) would be the most effective as PFOs in all countries pointed out that lack of financial resources is the main obstacle. The government could offer different financial mechanisms through EU Rural Development Program funds or loans at reasonable interest rates.

Since PFOs, who are prepared to produce additional quantities of woody biomass, are younger with bigger forest properties and interested in wood production, development of informational policy instruments targeted on education related to biomass production and marketing, and market information sharing, could be a good approach. Useful ways of

interacting with them are through face-to-face discussions and practical field demonstration, where PFOs, as well as professional foresters, may feel most comfortable to discuss possible benefits related to woody biomass production (Van Herzele and Van Gossum 2008). Furthermore, special office hours scheduled with foresters are required, where PFOs can discuss the possibilities of participation in the future biomass market, as well as concerning biomass prices, long term contracts, distribution procedures, trading rules and forest management obligations that proved as highly promising and that facilitate the access to basic information related to wood mobilization. Moreover, governments should also encourage wood mobilization through long-term binding contracts for the purchase of the woody biomass from PFOs, especially where PFOs are prepared to produce an additional quantity of woody biomass for the market, to be consumed in the public sector.

For PFOs who are not prepared to produce additional quantities of woody biomass, the most effective instruments would be informational ones. This is in line with the sixth principle of Smart Regulatory Framework, where less interventionist measures have the potential to deliver the desired policy outcome. Since the PFOs who are not prepared to produce additional quantities of woody biomass are the elderly and own smaller properties, »soft« policy instruments might motivate them (Pregernig 2001). Therefore, informational and motivational campaigns are needed to raise interest for managing their forests and perhaps produce additional quantities of woody biomass. It may be also beneficial to inform them or their successors about advantages concerning woody biomass production and the potential market.

Upon the selection of additional woody biomass mobilization instruments, it is also important to consider the regional market conditions (woody biomass price changes) and forest owner types, as in the analyzed countries there is a growing group of PFOs who are not participating in the wood market at all. This is certainly a limitation of the study. Nevertheless, additional research is also required to deepen the understanding of the conditions under which PFOs are prepared to produce additional quantities of woody biomass, to analyze the obstacles to mobilizing the resources, and develop innovative mobilization models primarily focused on public-private partnership. Moreover, a research on effectiveness and efficiency of policy instruments, as a means for pursuing and implementing renewable energy policies, is certainly required.

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